CALIFORNIA ENERGY COMMISSION

ACCEPTANCE REQUIREMENTS FOR NONRESIDENTIAL BUILDINGS

Nonresidential Quality Assurance Project

2005 California Building Energy Efficiency Standards

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1. Acceptance Requirements for Nonresidential Buildings

The California Energy Commission (CEC) received funding from the Department of Energy to complete the Nonresidential Building Quality Assurance Project. The overall project objectives include: developing the technical background for future changes to the Standards; identifying specific approaches to provide building owners with reliable energy savings; and developing alternative approaches to ensuring effective nonresidential building performance through the California Energy Efficiency Standards for Nonresidential Buildings (Standards).

This proposal outlines a set of recommendations that would establish Acceptance Requirements for Nonresidential Buildings through the Standards.

1.1. Description

Acceptance Requirements are defined as the application of targeted inspection checks and functional and performance testing conducted to determine whether specific building components, equipment, systems, and interfaces between systems conform to the criteria set forth in the Standards and to related construction documents (plans or specifications). Acceptance Requirements can effectively improve code compliance and help determine whether equipment meets operational goals and whether it should be adjusted to increase efficiency and effectiveness.

The recommended Acceptance Requirements will address three key areas:

1. The individuals and/or entities that are involved in the process of checking that the standards were met,
2. Scope of technologies, practices, strategies or systems to be included, and
3. The process of checking that the technology, practice, strategy or system was installed and performs according to design intent.

The proposal establishes a Certificate of Acceptance that must be completed by the installing contractor, engineer of record, or agent of the owner prior to receiving an occupancy permit.

1.2. Benefits

The energy benefits associated with this Acceptance Requirements proposal are currently included in the analysis of each measure. Historically, the Standards assume equipment operates throughout its useful life. These proposed requirements place an expectation on all building owners that their contractors properly install and test their equipment to assure it is functioning according to the intent of the Standards.

1.3. Environmental Impact

This measure will not have any adverse environmental impact.

1.4. Type of Change

The following describe the types of changes in more detail.

Mandatory Measure

This proposed change would require all plans to identify relevant information that will facilitate acceptance testing of a measure. In addition, the following mandatory measures would require acceptance testing:

- Outdoor Air Systems
- HVAC System Controls (time, isolation and overrides)
- Manual Daylight Switching

Prescriptive Requirement

If the following measures are installed they must pass certain acceptance tests:

- Air Distribution Systems (ducts)
- Automatic Lighting Controls (daylighting, time-of-day, occupancy)
- Economizers

Compliance Option

No changes are proposed at this time but future options may account for manufacturer certification of controls, factory installed economizers and other strategies that improve reliability and reduce failure rates.

Modeling

No changes are proposed to the modeling rules. Section 2.7 of the Nonresidential ACM Manual will be revised to require that the PERF-1 form will identify measures which require a Certificate of Acceptance.

Other

The administrative chapter of Title 20 will be modified to describe new compliance documentation requirements for the Certificate of Acceptance. Also, test requirements would be placed into the Standards for specific pieces of equipment and systems.

1.5. Measure Availability and Cost

Contractors, engineers or agents of the owner will conduct the acceptance inspections and tests. These individuals are responsible to the owner for the design, installation and operation of the equipment and in many cases, conduct similar tests prior to the owner accepting the work product. Costs for performing these tests are currently included in contractor rates as a part of their quality assurance process.

1.6. Useful Life, Persistence and Maintenance

The life and persistence of measure performance is an issue that touches all parts of the Standards. While a process to perform a one-time testing may deliver long-term savings over the life of some measures, it may not assure that other measures will deliver long-term savings.

For more sophisticated large-scale buildings and systems a one-time pre-occupancy performance check is far less likely to yield persistent savings. Acceptance testing will only assure that long-term savings are not impacted by improper installation and start-up.

For smaller systems, testing is likely to assure proper operation until component failures occur, or improper maintenance modifies the equipment performance.

1.7. Acceptance Testing

This section proposes the following process for implementing Acceptance Requirements. The implementation steps include the following:

- Plans are properly documented showing sensor locations, devices, control sequences and notes to assure the design meets the intent of the Standards,
- The installing contractor, engineer of record or owners agent reviews the installation, performs acceptance tests and documents results, and
- The installing contractor, engineer of record or owners agent documents the operating and maintenance information, installation certificates and test results on the Certificate of Acceptance and submits to the building department prior to receiving an occupancy permit.

It should be clearly understood that acceptance testing is not intended to take the place of commissioning or test and balance procedures that a building owner might incorporate into a building project. It is an adjunct process focusing only on assuring compliance with the Standards.

1.7.1. Plan Review

The installing contractor, engineer of record or owners agent shall be responsible for reviewing the plans and specifications to assure they conform to the Acceptance Requirements. This is typically done prior to signing a Certificate of Compliance. An example of this review for package unitary systems might include the following:

Table 1 - Example Plan Review Check

Review plans and verify proper documentation of the following.	Mechanical equipment (both heating and cooling, if applicable) must meet or exceed efficiency ratings per Standards Table B-9.
	All fan motors must meet or exceed efficiency rations per Standards Table B-8A and Table B-8B.
	Economizer is specified for all systems as required by Standards
	Specified thermostat includes all zone control features required by Standards Section 122(b).
	Specified equipment includes all system control features required by Standards Section 122(e).
	Specified heat pump includes all system control features required by Standards Section 122(d).
	Specified gas-fired equipment does not have pilot lights.
	Specified thermostat and system controls must allow the economizer to be fully integrated with the unit.
	Proper relief of outdoor air is provided through a relief damper or relief fan and associated controls.

1.7.2. Inspection and Testing

The installing contractor, engineer of record or owners agent shall be responsible for providing all necessary instrumentation, measurement and monitoring, and undertaking all required acceptance requirement procedures. They shall be responsible for correcting all performance deficiencies and again implementing the acceptance requirement procedures until all specified systems and equipment are performing in accordance with the Standards. An example of this procedure for package unitary equipment would include the following:

Table 2 - Example Inspection and Testing Procedure for Package Unitary Equipment

Prior to Performance Testing, verify and document the following:	Space temperature thermostat has been calibrated.
	Appropriate temperature deadband has been programmed.
	Appropriate occupied, unoccupied, and holiday schedules have been programmed.
	Outside air flow station is calibrated OR minimum outside air flow and damper position is set.
	Economizer lockout control sensor, if applicable, is calibrated (refer to the ECONOMIZERS acceptance requirements section for detail).
Step 1: Simulate heating load during occupied condition. Verify and document the following:	Supply fan operates continually during occupied condition.
	Gas-fired furnace, if applicable, stages on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
	Heat pump(s), if applicable, stage on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
	Outside air damper is open to the minimum position.
	Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.
Step 2: Simulate "no-load" during occupied condition. Verify and document the following:	Supply fan operates continually during occupied condition.
	The unit provides neither heating or cooling.
	Outside air damper is open to the minimum position.
	Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.
Step 3: Simulate cooling load and economizer operation, if applicable, during occupied condition. Verify and document the following:	Supply fan operates continually during occupied condition.
	Refer to the ECONOMIZERS acceptance requirements section for testing protocols.

Step 4: If an economizer is not required, simulate cooling load during occupied condition. Verify and document the following:	Supply fan operates continually during occupied condition.
	Compressor(s) stage on to satisfy cooling space temperature setpoint and space is maintained at +/- 2 °F.
	Outside air damper is open to the minimum position.
	Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.
Step 5: Shut the unit off or allow schedule to go unoccupied. Verify and document the following:	Supply fan turns off.
	Outside air damper closes completely.
Step 6: Simulate heating load during unoccupied condition. Verify and document the following:	Supply fan cycles on when heating equipment is enabled.
	Outside air damper remains closed.
	Gas-fired furnace, if applicable, stages on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
	Heat pump(s), if applicable, stage on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
	Supply fan cycles off when heating equipment is disabled.
Step 7: Simulate cooling load and economizer operation, if applicable, during unoccupied condition. Verify and document the following:	Supply fan cycles on when there is a call for cooling.
	Refer to the ECONOMIZERS acceptance requirements section for testing protocols.
	Supply fan cycles off when call for cooling is satisfied.
	Outside air damper closes when unit cycles off.
Step 8: If an economizer is not required, simulate cooling load during unoccupied condition. Verify and document the following:	Supply fan cycles on when cooling equipment is enabled.
	Outside air damper remains closed.
	Compressor(s) stage on to satisfy cooling space temperature setpoint and space is maintained at +/- 2 °F.
	Supply fan cycles off when cooling equipment is disabled.
Step 9: Simulate manual override during unoccupied condition. Verify and document the following:	System reverts to “occupied” mode and operates as described above to satisfy a heating, cooling, or no load condition.
	System turns off when manual override time period expires.

1.7.3. Certificate of Acceptance

The installing contractor, engineer of record or owners agent shall be responsible for documenting the results of the acceptance requirement procedures including paper and electronic copies of all measurement and monitoring results. They shall be responsible for performing data analysis, calculation of performance indices and crosschecking results with the requirements of the Standard. They shall be responsible for issuing a Certificate of Acceptance. Building departments shall not release a final Certificate of Occupancy until a Certificate of Acceptance is submitted that demonstrates that the specified systems and equipment have been shown to be performing in accordance with the Standards. The installing contractor, engineer of record or owners agent upon completion of undertaking all required acceptance requirement procedures shall record their State of California Contractor's License number or their State of California Professional Registration License Number on each Certificate of Acceptance that they issue.

1.7.4. Candidate Entities, Organization and Individuals

Groups or individuals that are involved in the building construction industry and that potentially have the skills and experience to complete the Certificate of Acceptance are as follows:

- Commissioning Agents
- Mechanical and electrical engineers
- Mechanical and electrical contractors
- Test and balance contractors

Organizations within each of these four groups likely have individuals knowledgeable of the fundamentals of acceptance testing at least in some categories of systems and equipment. Combinations of these four organizations are also likely to be a part of every construction project.

The potential roles, responsibilities and qualifications of each of the four groups are discussed below.

Of all four groups, the experienced *commissioning agent* may be the most qualified to undertake the acceptance testing duties. The commissioning agent is likely an engineer with in depth knowledge of building systems and equipment. They also likely have access to high quality measurement and monitoring instruments and are adept at data analysis and calculation of performance indices.

The drawback with this group is that there are a limited number of qualified commissioning agents available in California. It would not be possible to provide adequate acceptance testing coverage to the new construction marketplace by using only commissioning service providers.

Mechanical and electrical engineers have the in depth knowledge in their respective fields of the systems and equipment that require acceptance testing. They have the ability to undertake data analysis and calculate performance indices. They may not have the hands-on field experience to undertake measurement and monitoring. They also may not have access to high quality measurement and monitoring instruments.

As a stand-alone business, acceptance testing would likely under utilize the mechanical or electrical engineer's skills and experience. It could be an adjunct to their engineering practice.

Mechanical and electrical contractors including sub-categories of piping, sheet metal, controls, lighting contractors and so forth are typically responsible for system and equipment fabrication, installation and start-up. They may be responsible for test and balance work on smaller projects. They could have engineers on staff with similar qualifications to mechanical and electrical consultant firms. The mechanical and electrical contractors are less likely to have experience with measurement, monitoring, data analysis and calculation of performance indices.

Test and balance (TAB) contractors are usually present on larger and more sophisticated construction projects. They may not be present on the smaller projects where the mechanical and electrical contractors are more likely to provide TAB services. Their responsibilities are to test, adjust and balance air and water delivery systems to assure that the design intent is being met. They may do acceptance testing where it is required on projects. Data analysis and the calculation of performance indices are not necessarily a part of the regular services that they provide.

Test and balance contractors have national certification organizations. These are the Associated Air Balance Council (AABC) and the National Environmental Balancing Bureau (NEBB). These two organizations put forth qualification criteria for certification and test individuals to assure that they are qualified. Membership in organizations such as these or certification is not necessarily a requirement for test and balance contractors in California. However, specifications, which are typically a part of the contract documents for most building projects may require that the TAB contractors belong to such organizations. AABC's detailed TAB specification is included as Appendix for information purposes (not part of the proposed Acceptance Requirements).

1.8. Cost Effectiveness

The savings associated with verifying performance is an inherent part of the measure savings. Another way of stating this is that the current cost-effectiveness assumptions are based on the measure performing perfectly for the life of the measure. Therefore acceptance testing does not have to be cost-effective on its own, but as a package when considering the cost of the measure, cost of verification and savings associated with the measure. The process itself will not be subject to a separate cost-effectiveness analysis independent of measure savings.

1.9. Analysis Tools

The current reference method is capable of providing the results for the proposed approach.

1.10. Relationship to Other Measures

This measure will impact the standards language of the following measures:

- Section 121: Ventilation
- Section 122: HVAC Controls
- Section 131: Lighting Controls
- Section 144: Economizers

In addition, the following measure will be modified in a limited way to be consistent with the acceptance testing process. Compliance credit for sealed air distribution systems will continue to require third-party field verification as specified by Section 2.4.2.35 and Appendix G of the Nonresidential ACM Manual:

- Section 144: Air Distribution Systems installed in unconditioned spaces between insulated ceilings and roofs for Package HVAC equipment

1.11. Draft Standards Language

1.11.1. Section 10 (Title 20)

Part 1

Add to Section 10-102:

"Acceptance Requirements" means "acceptance requirements for code compliance" as defined in Section102(b) of Part 6.

Reason:

This change makes the definitions in Title 24, Part 1 consistent with those proposed in Title 24, Part 6.

Part 2

Modify Section 10-103(a)(2)(B) as follows:

(B) Plans and specifications submitted with each application for a building permit shall show the characteristics of each feature, material, component, and manufactured device proposed to be installed in order to have the building meet the requirements of Part 6, and of any other feature, material, component, or manufactured device that Part 6 requires be indicated on the plans and specifications. Plans and specifications submitted with each application for a building permit shall provide acceptance requirements for code compliance of any feature, material, component or manufactured device required under Part 6. Plans and specifications for Nonresidential buildings shall require that within 90 days after Enforcement Agency issues a final occupancy permit, record drawings be provided to the building owner. Record drawings shall include, but not be limited to, the location and performance data on each piece of equipment, general configuration of ducts and pipe distribution systems, including sizes, and the terminal air and water design and measured flow rates. If any characteristic is materially changed before final construction and installation, such that the building may no longer comply with Part 6, the building must be brought back into compliance, and so indicated on amended plans, specifications, and Certificate(s) of Compliance and shall be submitted to the enforcement agency. Such characteristics shall include the efficiency (or other characteristic regulated by Part 6) of each device.

Reason:

This change to the administrative requirements clarifies the intent of existing language in the Standard that refers to installation requirements contained in Section 10-103(a)(3) and start-up, calibration and/or completion requirements contained in Part 6.

Section 10-103(a)3 requires an installation certificate for systems, equipment and building components regulated in Section 110 through 119. For example, an installation certificate is currently required when installing automatic lighting controls. The requirement in Section 119 states that start-up and calibration be performed, but doesn't specify that the plans document this requirement nor specify how to test that the controls are properly installed. The proposed text clarifies the documentation of such requirements contained in the Standards. It also requires that plans indicate critical record drawing information be submitted to the building owner within 90 days of the issuance of a final occupancy permit.

Part 3

Add Section 10-103(b):

(b) Certificate of Acceptance. For all new buildings designated to allow a conditioned use of an occupancy group or type regulated by Part 6 the applicant shall file Certificate(s) of Acceptance prior to receiving a final occupancy permit. The signer (s) shall be eligible under Division 3 of the Business and Professions code to sign such documents. The Certificate(s) shall be readily legible and of substantially similar format and informational order and content to the Certificate(s) in the Nonresidential Manual, as defined in Part 6. The Certificate(s) shall be approved by the local enforcement agency by stamp or authorized signature and shall indicate that:

1. the applicant has demonstrated acceptance requirements as indicated in the plans and specifications submitted under section 10-103(a),

2. installation certificates described in section 10-103(a)(3) are posted, or made available with the building permit(s) issued for the building, and

3. that operating and maintenance information described in sections 10-103(b) and 10-103(c) were provided to the building owner

Renumber remaining sections

Reason:

This change defines what the Certificate of Acceptance requires of the applicant, including documentation of the results of the acceptance tests, posting of installation certificates and transfer of manuals and operating instructions to the building owner. In addition, it specifies who is responsible for signing the Certificate, and references the Nonresidential Manual for the format of the Certificate.

Part 4

Modify Section 10-103(b)(1):

(1) Operating Information. The builder shall provide the building owner at occupancy the appropriate Certificate(s) of Compliance, Certificate (s) of Acceptance and a list of the features, materials, components, and mechanical devices installed in the building and instructions on how to operate them efficiently. The instructions shall be consistent with specifications set forth by the Executive Director.

For residential buildings, such information shall, at a minimum, include information indicated on forms Certificate of Compliance (CF-1R), Mandatory Measures (MF-1R), Installation Certificate (CF-6R), Insulation Certificate (IC-1), and a manual which provides all information specified in this Section 10-103(b). The Home Energy Manual (P400-92-031, July 1992) may be used to meet the requirement for providing this manual.

For nonresidential buildings, such information shall, at a minimum, include information required by the Certificates of Compliance, Certificate of Acceptance, forms ENV-1, MECH-1 and LTG-1, an installation certificate and an insulation certificate. For dwelling units, buildings or tenant spaces which are not individually owned and operated, or are centrally operated, such information shall be provided to the person(s) responsible for operating the feature, material, component or mechanical device installed in the building.

Reason

This change specifies documentation necessary for the enforcement agency to verify that the administrative requirements contained in Section 10-103 were implemented prior to the issuance of a final occupancy permit. This is consistent with the intent of the current Certificate of Compliance requirements and clarifies the responsibility of the person with overall responsibility for the project.

Part 5

Add to Section 102(b)

ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE is a description of test procedures that includes equipment and systems to be tested, functions to be tested, conditions under which the test shall be performed, level of rigor, results to be obtained and measurable criteria for acceptable performance.

Reason

This change creates a definition of "acceptance requirements for code compliance" in Section 10 of Title 20.

1.11.2. Title 24 (Sections 121, 122, 131 and 144)

Part 1

Delete Section 121(f) and replace with the following:

(f) Outside Air Acceptance. Before an occupancy permit is granted for a new building or space, or a new space-conditioning or ventilating system serving a building or space is operated for normal use, all ventilation systems serving the building or space shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies plans and specifications meet the requirements of Section121 (a) 2, and
3. Certifies measured outside air is within ten (10) percent of the minimum ventilation rate specified in the plans and specifications.

Reason

Section 121 currently requires that outdoor air system be documented as meeting minimum outdoor air requirements prior to issuing an occupancy permit. This section uses the proposed Acceptance Requirements procedure to document outdoor air rates.

Part 2

Add Section 122 (h) as follows:

(h) Space-conditioning Controls Acceptance. Before an occupancy permit is granted for a new building or space, or a new space-conditioning or ventilating system serving a building or space is operated for normal use, all space-conditioning controls serving the building or space shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies that the space-conditioning system meets the requirements of Section 121 (c) 1.
3. Certifies that space-conditioning controls meet the requirements of Section 122 (a) through Section 122 (g).

Reason

Section 122 requires certain control functions to be provided for each space-conditioning system. This proposed requirement uses the proposed Acceptance Requirements procedure to document their proper specification, installation and operation.

Part 3

Add Section 144(h) as follows:

(h) Air Distribution System Duct and Plenum Acceptance. Before an occupancy permit is granted for a new building or space, or a new space-conditioning or ventilating system serving a building or space is operated for normal use, all air distribution system ducts and plenums serving the building or space shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies that air distribution ducts and plenums meet the requirements of Section 124 (a) through Section 124 (h).
3. Certify that air distribution ducts and plenums do not leak more than 6% of total measured fan flow as specified in the Nonresidential ACM Manual.

EXCEPTION to Section 144 (h): Variable air volume (VAV) systems, non-unitary air-conditioners and heat pumps with ducts installed is spaces other than unconditioned spaces between insulated ceilings and roofs.

Reason

This proposed change requires acceptance testing for compliance credit for sealing of duct systems installed in unconditioned spaces between insulated ceilings and roofs for Package HVAC equipment. Third-party field verification also is required as specified in Section 2.4.2.35 and Appendix G of the Nonresidential ACM Manual.

Part 4

Add Section 131(g) as follows:

(g) Lighting Control Acceptance. Before an occupancy permit is granted for a new building or space, or a new lighting system serving a building or space is operated for normal use, all lighting controls serving the building or space shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies that automatic daylighting controls meet the requirements of Section 119(e) through Section 119 (g).
3. Certifies that lighting controls meet the requirements of Section 131(a) through Section 131 (c) and Sections 131 (e) and (f).
4. Certifies that automatic lighting controls meet the requirements of Section119 (c) and 131 (d).
5. Certifies that occupant-sensing devices meet the requirements of Section119 (d) and 131 (d).

Reason

This proposed change requires that lighting control devices be subject to the proposed Acceptance Requirements procedure.

Part 5

Add Section 144(e)2.C.

C. Before an occupancy permit is granted for a new building or space, or a new space-conditioning system serving a building or space is operated for normal use, all economizers serving the building or space shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies that the economizers meet the requirements of Section 144 (e) 1, 2, and 3.

Reason

This proposed change requires economizers to be certified as meeting the Acceptance Requirements for Code Compliance.

1.12. Bibliography and Other Research

Nonresidential Quality Assurance Project, Verifying the Performance of New Nonresidential Buildings, Final Report, April 30, 2001 (www.newbuildings.org/downloads/codes/NRQAreport.pdf)

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Delp, W. W., N. E. Matson, E. Tshudy, M. P. Modera, and R. C. Diamond. 1997. Field investigation of duct system performance in California light commercial buildings. Lawrence Berkeley National Laboratory, Report #40102.

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Appendix A: Associated Air Balance Council's Test, Adjust and Balance Specification

This section is included here for information purposes and is not a part of the proposed Acceptance Requirements.

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All division 15 specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to in this section.

1.02 SCOPE OF WORK

A. The owner will contract with an independent testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the HVAC systems.

B. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

C. The items requiring testing, adjusting, and balancing include the following:

AIR SYSTEMS:

Supply Fan AHU

Return Fans

Relief Fans

Exhaust Fans

Zone branch and main ducts

VAV systems

Diffusers, Registers and Grilles

Coils (Air Temperatures)

1.03 DEFINITIONS, REFERENCES, STANDARDS

A. All work shall be in accordance with the latest edition of the AABC National Standards. If these contract documents set forth more stringent requirements than the AABC National Standards, these contract documents shall prevail.

1. AABC: The Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing, adjusting, and balancing HVAC systems. The AABC National Standards (latest edition), provides standards and operational criteria for HVAC systems.

1.04 QUALIFICATIONS

A. Agency Qualifications: The TAB Agency shall be a current member of the Associated Air Balance Council (AABC).

1.05 SUBMITTALS

A. Qualifications: The TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer (TBE) certificate.

B. Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.

C. Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

1.06 TAB PREPARATION AND COORDINATION

A. Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to the start of TAB work.

B. System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin.

C. The building control system shall be complete and operational. The Building Control System contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

D. All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

E. Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.07 REPORTS

A. Final TAB Report - The TAB agency shall submit the final TAB report for review by the engineer. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.

Submit 4 copies of the Final TAB Report.

1.08 DEFICIENCIES

A. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

PART 2 - INSTRUMENTATION

A. All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

PART 3 - EXECUTION

3.01 GENERAL

A. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed.

The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or - 10% unless otherwise stated.

B. Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

C. All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.

3.02 AIR SYSTEMS

A. The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:

For supply fans:

1. Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM.

4. Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 20 degrees Fahrenheit or use the difference between Pitot tube traverses of the supply and return air ducts.

5. Static Pressure - Test and record system static profile of each supply fan.

For return fans:

1. Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of the main return ducts to obtain total CFM.

4. Static Pressure - Test and record system static profile of each return fan.

For relief fans:

1. Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

3. Static Pressure - Test and record system static profile of each relief fan.

4. Pitot Tube Traverse - If possible, per system ductwork, perform a traverse to determine Relief Air CFM.

For exhaust fans:

1. Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main exhaust ducts to obtain total CFM.

4. Static Pressure - Test and record system static profile of each exhaust fan.

For zone, branch and main ducts:

1. Adjust ducts to within design CFM requirements. As applicable, at least one zone-balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

For VAV systems:

1. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements.

2. Identification - Identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.

For diffusers, registers and grilles:

1. Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts.

2. Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

For coils:

1. Air Temperature - Once airflows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

Appendix B: Proposed Test Requirements

This appendix includes recommended acceptance requirements for outside air ventilation for variable air volume systems, economizers, packaged HVAC systems, duct, and lighting controls. These requirements would be incorporated into the Nonresidential ACM Manual, Design Manual or Standards as appropriate.

B.1 Outdoor Air Acceptance Requirements Narrative

B.1.a Ventilation OSA flow requirements at central air handling unit

Plan Review

Verify the construction documents for the following:

- Outside air ventilation rate meets the Standards for all areas served by the air-handling unit being reviewed.

Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- Outside air flow station is calibrated *OR* a calibration curve of outside air vs. outside air damper position, inlet vane signal, or VFD signal was completed during system TAB procedures.
- Disable economizer control sequences to prevent unwanted interaction while performing tests.

Equipment Start-up

Step 1: Drive all VAV boxes to minimum flow. Verify and document the following:

- Measured outside airflow CFM corresponds to the total value found on the Standards Mechanical Plan Check document MECH-3, Column H or Column I (which ever is greater) within +/- 10%.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 2: Drive all VAV boxes to maximum flow. Verify and document the following:

- Measured outside airflow CFM corresponds to the total value found on Standards Mechanical Plan Check document MECH-3, Column H or Column I (which ever is greater) within +/- 10%.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

B.2 Packaged HVAC Systems Acceptance Requirements Narrative

Acceptance requirements apply only to constant volume, direct expansion (DX) packaged systems with gas furnaces or heat pumps.

B.2.a Constant Volume Packaged HVAC Systems

Plan Review

Verify the Plan Review for the following:

- Mechanical equipment (both heating and cooling, if applicable) must meet or exceed efficiency ratings per Standards Table B-9.
- All fan motors must meet or exceed efficiency rations per Standards Table B-8A and Table B-8B
- Economizer is specified for all systems as required by Standards
- Specified thermostat includes all zone control features required by Standards Section 122(b).
- Specified equipment includes all system control features required by Standards Section 122(e).
- Specified heat pump includes all system control features required by Standards Section 122(d).
- Specified gas-fired equipment does not have pilot lights.
- Specified thermostat and system controls must allow the economizer to be fully integrated with the unit.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Space temperature thermostat has been calibrated.
- Appropriate temperature deadband has been programmed.
- Appropriate occupied, unoccupied, and holiday schedules have been programmed.
- Outside air flow station is calibrated *OR* minimum outside air flow and damper position is set during system TAB procedures.
- Economizer lockout control sensor, if applicable, is calibrated (refer to the *ECONOMIZERS* acceptance requirements section for detail).

Equipment Start-up

Step 1: Simulate heating load during occupied condition. Verify and document the following:

- Supply fan operates continually during occupied condition.
- Gas-fired furnace, if applicable, stages on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
- Heat pump(s), if applicable, stage on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
- Outside air damper is open to the minimum position.
- Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.

Step 2: Simulate “no-load” during occupied condition. Verify and document the following:

- Supply fan operates continually during occupied condition.

- Neither heating or cooling are provided by the unit.
- Outside air damper is open to the minimum position.
- Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.

Step 3: Simulate cooling load and economizer operation, if applicable, during occupied condition.

- Supply fan operates continually during occupied condition.
- Refer to the *ECONOMIZERS* acceptance requirements section for testing protocols.

Step 4: If an economizer is not required, simulate cooling load during occupied condition. Verify and document the following:

- Supply fan operates continually during occupied condition.
- Compressor(s) stage on to satisfy cooling space temperature setpoint and space is maintained at +/- 2 °F.
- Outside air damper is open to the minimum position.
- Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.

Step 5: Shut the unit off or allow schedule to go unoccupied. Verify and document the following:

- Supply fan turns off.
- Outside air damper closes completely.

Step 6: Simulate heating load during unoccupied condition. Verify and document the following:

- Supply fan cycles on when heating equipment is enabled.
- Outside air damper remains closed.
- Gas-fired furnace, if applicable, stages on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
- Heat pump(s), if applicable, stage on to satisfy heating space temperature setpoint and space is maintained at +/- 2 °F.
- Supply fan cycles off when heating equipment is disabled.

Step 7: Simulate cooling load and economizer operation, if applicable, during unoccupied condition.

- Supply fan cycles on when there is a call for cooling.
- Refer to the *ECONOMIZERS* acceptance requirements section for testing protocols.
- Supply fan cycles off when call for cooling is satisfied.
- Outside air damper closes when unit cycles off.

Step 8: If an economizer is not required, simulate cooling load during unoccupied condition. Verify and document the following:

- Supply fan cycles on when cooling equipment is enabled.
- Outside air damper remains closed.

- Compressor(s) stage on to satisfy cooling space temperature setpoint and space is maintained at +/- 2 °F.
- Supply fan cycles off when cooling equipment is disabled.

Step 9: Simulate manual override during unoccupied condition. Verify and document the following:

- System reverts to "occupied" mode and operates as described above to satisfy a heating, cooling, or no load condition.
- System turns off when manual override time period expires.

B.3 Ducts Acceptance Requirements Narrative

Acceptance requirements apply only to qualify for compliance credit for sealed ducts for single-zone packaged systems with ducts installed in unconditioned spaces between insulated ceilings and roofs.

B.3.a Duct Leakage

Plan Review

Verify the Plan Review for the following:

- Specified ducts should be UL 181 listed
- Specified pressure sensitive tapes, mastics, aerosol sealants, or other closure systems meet applicable requirements of UL 181, 181A, or 181B. Cloth backed rubberized adhesive tapes are prohibited unless used in combination with mastic and drawbands.
- Must comply with Sections 601, 602, 604, 605 and Standard 6-5 of the 2001 CMC

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Flexible duct layout does not have any sharp corners and bends.
- Drawbands are either stainless steel worm-drive hose clamps or UV-resistant nylon duct ties.
- Flexible ducts are not constricted in any way (for example pressing against immovable objects or squeezed through openings)
- Duct leakage tests should be performed before access to ductwork and associated connections are blocked by permanently installed construction material.
- Joints and seams are not sealed with a cloth back rubber adhesive tape unless used in combination with mastic and drawbands.
- Duct R-values are verified.
- Insulation is protected from damage and suitable for outdoor service if applicable.

Equipment Start-up

Step 1: Perform duct leakage test per 2001 Nonresidential ACM Approved Manual, Appendix G, Section 4.3.8.2. Certify the following:

- Duct leakage does not exceed 6% of total measured fan flow when tested according to the Nonresidential ACM Manual.

Step 2: Obtain third party field verification as required by Appendix G.

B.4 Lighting Controls Acceptance Requirements Narrative

Lighting control testing is performed on:

- Manual Daylighting Controls
- Automatic Daylighting Controls
- Occupancy Sensors
- Lumen Maintenance Controls
- Automatic Time-switch Control.

B.4.a Automatic Daylighting Controls

Plan Review

Verify the Plan Review for the following:

- Evaluate potential external shading issues that could affect daylight from entering the space. This includes reviewing landscaping design and physical location of the proposed building and adjacent structures. If exterior obstructions severely reduce the amount of available light, daylight controls are not required.
- Review visible light transmittance for all glazing specified and calculate the *Effective Aperture* for both vertical windows and skylights per the Standards. If the *Effective Aperture* calculation falls below the minimum threshold per the Standards, daylight controls are not required.
- Calculate the daylit area per the Standards and verify and document that all light fixtures within the daylit area are correctly wired to achieve the desired control.
- All manual switches and/or dimmers are wired appropriately per the Standards within the daylit area to achieve the desired control (mandatory requirement unless choose control option).
- All automatic control devices (photosensors) specified within the daylit area are located appropriately to achieve the desired control (lighting control credit option).[1]

[1] The issue of adequate location of photo-sensing devices to achieve daylight control may require more detailed investigation into design practices and manufacturer's recommended installations.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Ballasts specified for light fixtures within the daylit area meet all Standards requirements, including "reduced flicker operation" for continuously dimming and stepped dimming control systems.
- A time delay or switching dead band value of 3 minutes, per Standards, Section 119(e), is programmed into the stepped dimming and stepped switching daylight control system, respectively, to prevent short cycling.
- All daylight control systems provide a visual or audible signal to indicate device failure.
- All control devices (photocells) have been properly located, calibrated for appropriate set points and threshold light levels.

Equipment Start-up

Step 1: Simulate bright conditions for a continuous dimming control system. Verify and document the following:

- Lighting power reduction is at least 50% under fully dimmed conditions per Standard Section 119(e).1.
- Automatic daylight control system reduces the amount of light delivered to the space uniformly.
- Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e).2. The Standards Manual defines reduced flicker operation as "the operation of a light, in which the light has a visual flicker less than 30% for frequency and modulation". .

Step 2: Simulate dark conditions for a continuous dimming control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space uniformly.
- Dimming control system provides reduced flicker operation over the entire operating range per Standards Section 119(e).2. The Standards Manual defines reduced flicker operation as "the operation of a light, in which the light has a visual flicker less than 30% for frequency and modulation".

Step 3: Simulate bright conditions for a stepped dimming control system. Verify and document the following:

- Lighting power reduction is at least 50% under fully dimmed conditions.
- Automatic daylight control system reduces the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Stepped dimming control system provides reduced flicker over the entire operating range per Standards Section 119(e).2. The Standards Manual defines reduced flicker operation as "the operation of a light, in which the light has a visual flicker less than 30% for frequency and modulation".
- Minimum time delay between step changes is 3 minutes to prevent short cycling.

Step 4: Simulate dark conditions for a stepped dimming control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Stepped dimming control system provides reduced flicker over the entire operating range per Standards Section 119(e).2. The Standards Manual defines reduced flicker operation as "the operation of a light, in which the light has a visual flicker less than 30% for frequency and modulation".
- Minimum time delay between step changes is 3 minutes to prevent short cycling.

Step 5: Simulate bright conditions for a stepped switching control system. Verify and document the following:

- Lighting power reduction is at least 50% under fully switched conditions per Standards Section 119(e).1.
- Automatic daylight control system reduces the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Single- or multiple-stepped switching controls will have sufficient dead band between switching thresholds to prevent short cycling.

Step 6: Simulate dark conditions for a stepped switching control system. Verify and document the following:

- Automatic daylight control system increases the amount of light delivered to the space per manufacturer's specifications for power level verses light level.
- Single- or multiple-stepped switching controls will have sufficient dead band between switching thresholds to prevent short cycling.

Step 7: Simulate system failure or malfunction for all daylight control systems. Verify and document the following:

- Visual or audible device indicates system problem.

B.4.b Occupancy Sensors

Plan Review

Verify the Plan Review for the following:

- All occupancy sensors are located appropriately to achieve the desired control.
- Total lighting load on each occupancy sensor is within manufacturer' specifications.
- Specified ultrasonic occupancy sensors comply with minimum health requirements per Standards Section 119(d).1.A.
- Specified microwave occupancy sensors comply with minimum emission requirements per Standards Section 119(d).2.A.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Occupancy sensitivity has been calibrated to minimize false signals.

- Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.
- Ultrasound occupancy sensors do not emit audible sound.
- Ultrasound occupancy sensors do not emit ultrasound decibel values per Standards Section 119(d).1.C.
- Microwave occupancy sensors do not emit radiation in excess of one milliwatt per square centimeter measured at no more than five centimeters from the emission surface of the device.

Equipment Start-up

Step 1: Simulate an unoccupied condition. Verify and document the following:

- Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from the start of an unoccupied condition per Standard Section 119(d).
- Signal sensitivity is adequate to achieve desired control.

Step 2: Simulate an occupied condition. Verify and document the following:

- Status indicator or annunciator operates correctly.
- Lights controlled by occupancy sensors turn on immediately upon an occupied condition, *OR s*ensor indicates space is "occupied" and lights are turned on manually (automatic OFF and manual ON control strategy).

B.4.c Manual Daylighting Controls

Plan Review

Verify the Plan Review for the following:

- Calculate the daylit area per the Standards and verify and document that all light fixtures within the daylit area are correctly wired and switched to achieve the desired control.
- All automatic control devices (photosensors) specified within the daylit area are located appropriately to achieve the desired control (lighting control credit option).[2]

Construction Inspection

Prior to Performance Testing, verify and document the following:

- If dimming ballasts are specified for light fixtures within the daylit area, make sure they meet all the Standards requirements, including "reduced flicker operation" for manual dimming control systems.

Equipment Start-up

Step 1: Perform manual switching control. Verify and document the following:

- Manual switching achieves the required minimum lighting power reduction, *OR*

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[2] The issue of adequate location of photo-sensing devices to achieve daylight control may require more detailed investigation into design practices and manufacturer's recommended installations.

- Manual dimming achieves the required minimum lighting power reduction (both per Standard Section 131(b).

B.4.d Automatic Time Switch Control

Plan Review

Verify the Plan Review for the following:

- Timed manual override switch shall control an area not exceeding 5,000 square feet of illuminated space.
- Multi-story buildings have separate control per floor (either independent system or multiple point control system).
- Automatic time switch control system specified by designer includes at least a 10-hour power back-up capacity.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Automatic time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.
- Override time limit is no more than 2 hours.

Equipment Start-up

Step 1: Simulate occupied condition. Verify and document the following:

- All lights operate.

Step 2: Simulate unoccupied condition. Verify and document the following:

- Visual or audible annunciators warn that the lights are about to be turned off.
- All non-exempt lighting turn off.
- Manual override switch allows lights in the selected area to turn on.
- Visual or audible annunciators warn that the lights are about to be turned off when the override time has expired.
- All non-exempt lighting turns off.

B.5 Economizers Acceptance Requirements Narrative

Economizer testing is performed on all built-up systems and on packaged systems per Standards Section 144(e).1..

B.5.a Packaged Systems

Plan Review

Verify the Plan Review for the following:

- Economizer is specified for all systems as required by the Standards.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Economizer lockout control sensor is calibrated (fixed or differential dry-bulb or enthalpy sensor depending on system type)
- Outside air flow station is calibrated *OR* minimum outside air flow is measured and damper position set during system TAB procedures.
- Economizer lockout setpoint complies with Table 1-X3 per Standards Section 144(e).3.
- System controls are wired correctly to ensure economizer is fully integrated (i.e. economizer will operate when mechanical cooling is enabled).
- Economizer lockout control sensor location is adequate (open to air but not exposed to direct sunlight nor in an enclosure; away from sources of building exhaust; at least 25 feet away from cooling towers).

Equipment Start-up

Step 1: Simulate a cooling load and enable the economizer by adjusting the lockout control (fixed or differential dry-bulb or enthalpy sensor depending on system type) setpoint. Verify and document the following:

- Economizer damper modulates opens per Standards Section 144(e).1.A to maximum position to satisfy cooling space temperature setpoint.
- Return air damper modulates closed and is completely closed when economizer damper is 100% open.
- Economizer damper is 100% open before mechanical cooling is enabled.
- Mechanical cooling is only enabled if cooling space temperature setpoint is not met with economizer at 100% open.

Step 2: Continue from Step 1 and disable the economizer by adjusting the lockout control (fixed or differential dry-bulb or enthalpy sensor depending on system type) setpoint. Verify and document the following:

- Economizer damper closes to minimum position.
- Return air damper opens to normal operating position.
- Measured minimum outside airflow CFM corresponds to the value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.

- Mechanical cooling remains enabled until cooling space temperature setpoint is met.

B.5.b Built-up Systems

Plan Review

Verify the Plan Review for the following:

- Supply air, return air, and mixed air temperature sensors, as applicable, are specified appropriately to achieve the desired control. The mixed air sensor should be an averaging rather than a single-point sensor
- Outside air and return air dampers are linked to operate opposite of each other.

Construction Inspection

Prior to Performance Testing, verify and document the following:

- Economizer lockout control sensor is calibrated (fixed or differential dry-bulb and/or enthalpy sensors depending on how the system is to be controlled)
- Supply air, return air, and mixed air temperature sensors, as applicable, are calibrated.
- Economizer lockout setpoint complies with Table 1-X3 per Standards Section 144(e).3 and control sequence allows economizer to be fully integrated (i.e. can operate when mechanical cooling is enabled).
- Economizer lockout control sensor location is adequate (open to air but not exposed to direct sunlight nor in an enclosure; away from sources of building exhaust; at least 25 feet away from cooling towers).
- Measure mixed air temperature across mixed air plenum to ensure air handling unit achieves adequate mixing of outside air and return air.
- Disable supply air temperature reset controls to prevent unwanted interaction while performing tests.
- Disable supply fan static pressure reset controls to prevent unwanted interaction while performing tests.

Equipment Start-up

Economizer test procedure is based on a deviation from supply air temperature setpoint.

Step 1: Starting with full heating, verify and document the following:

- Outside air and return air dampers are positioned as necessary to satisfy minimum outside air flow requirements.
- Measured minimum outside airflow CFM corresponds to the total value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.
- Heating coil valve, if applicable, modulates to maintain supply air temperature within +/- 5% of setpoint.
- Chilled water valve is fully closed.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 2: As supply air temperature increases above setpoint, verify and document the following:

- Heating coil valve, if applicable, modulates from fully open to fully closed to maintain supply air temperature within +/- 5% of setpoint.
- Measured minimum outside airflow CFM corresponding to Standards MECH-1, Design O.A. CFM remains constant.
- Chilled water valve remains fully closed.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 3: As supply air temperature continues to increase above setpoint, verify and document the following:

- Heating coil valve, if applicable, is fully closed.
- Outside air damper modulates open toward 100% OSA position to maintain supply air temperature within +/- 5% of setpoint.
- Return air damper modulates to the closed position.
- Chilled water valve remains fully closed.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 4: As supply air temperature continues to increase above setpoint, verify and document the following:

- Heating coil valve, if applicable, remains fully closed.
- Outside air damper remains at 100% OSA position and return air damper remains closed.
- Chilled water valve modulates from fully closed to fully open to maintain supply air temperature within +/- 5% of setpoint.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).

Step 5: Reset economizer lockout setpoint below the actual outside air conditions. Verify and document the following:

- Outside air dampers modulate closed and return air dampers modulate open to satisfy minimum outside air flow requirements.
- Measured minimum outside airflow CFM corresponds to the total value found on Standards Mechanical Plan Check document MECH-1, Design O.A. CFM within +/- 10%.
- Heating coil valve, if applicable, remains closed.
- Chilled water valve modulates from fully closed to fully open to maintain supply air temperature within +/- 5% of setpoint.
- System operation stabilizes within 15 minutes after test procedures are initiated (no hunting).